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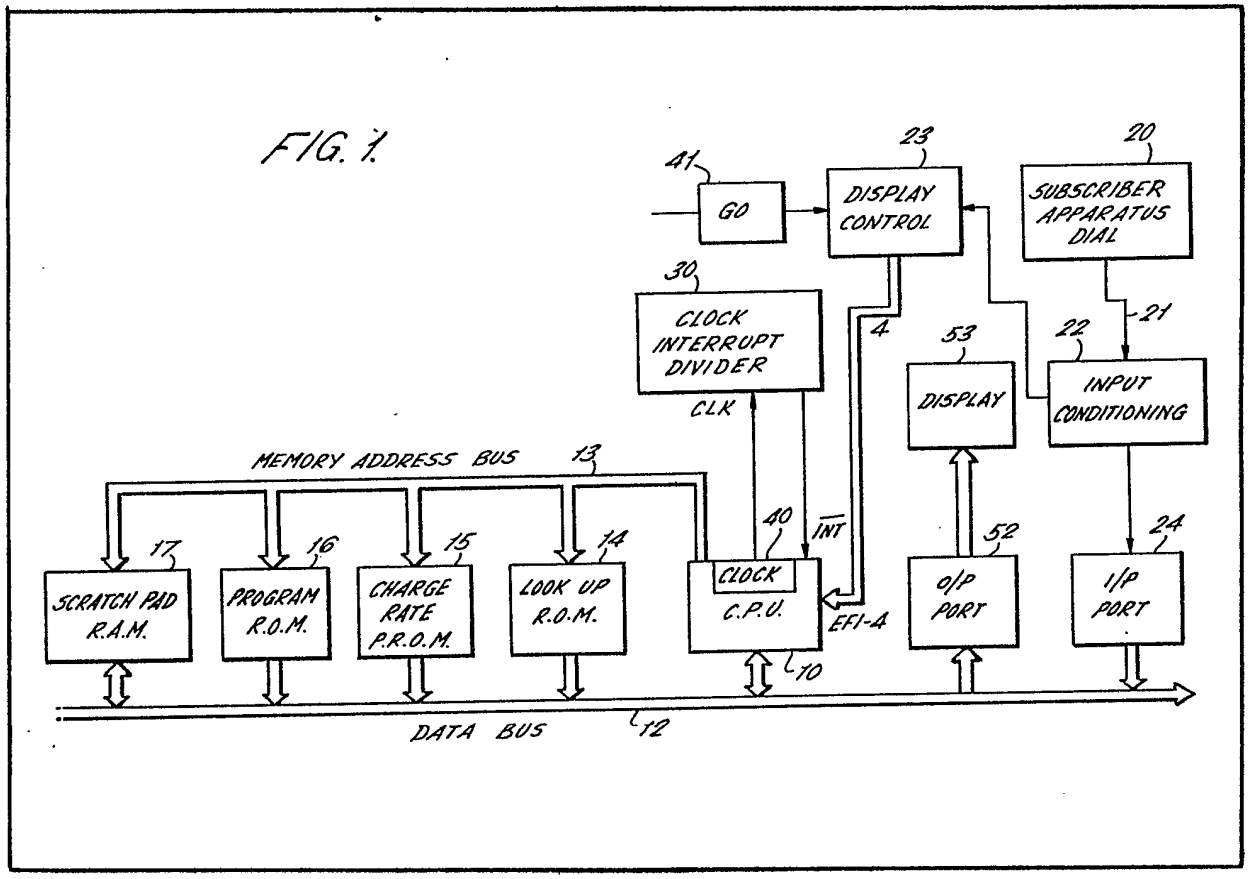
(54) Telephone call cost calculator

(57) A calculator for determining and indicating the cost of a telephone call or calls from subscriber apparatus comprises a data processor, e.g. a microprocessor 10, with associate memory means (14—17) for storing program instructions and data defining call charge bands. The charge band is determined by comparing the first digit or first few digits, as necessary, of the dialled number with data in the memory. Timing means including a clock/calendar are provided to select the appropriate charge rate in a charge band. Timing is initiated by means 41, e.g. a press-button operated by the subscriber and/or automatic means determining the completion of a connection or possibly at a predetermined delay time after the end of dialling or sensing of the ringing tone.

A display 53 selectively displays the current cost of a call or the cumulative cost of calls over a period.



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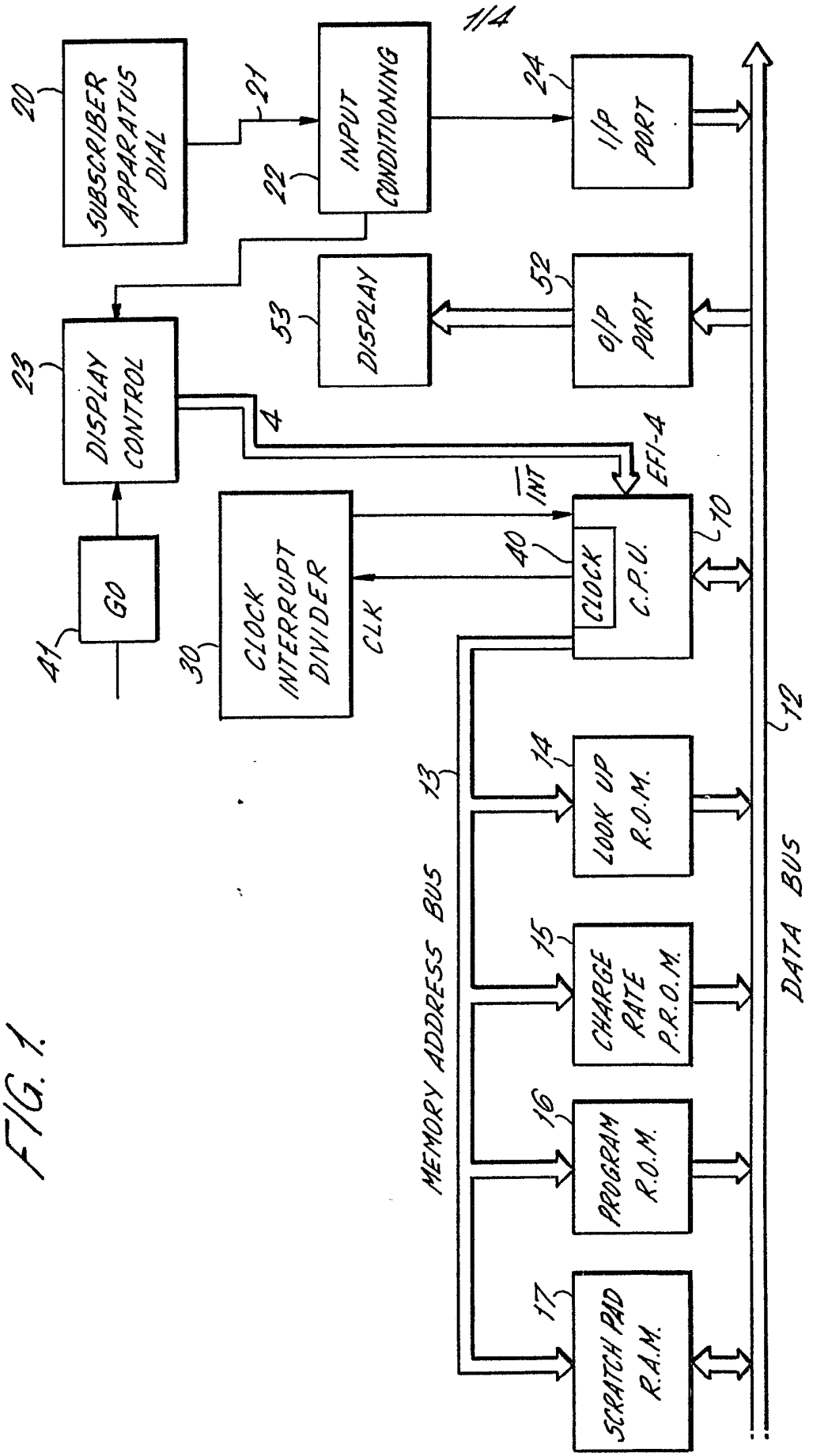

20
SUBSCRIBER APPARATUS DIAL
21
22
INPUT CONDITIONING
24
I/P PORT
23
DISPLAY CONTROL
53
DISPLAY
52
O/P PORT
4
EFI-4
INT
40
CLOCK
C.P.U.
10
41
GO
30
CLOCK INTERRUPT DIVIDER
CLK
13
MEMORY ADDRESS BUS
14
LOOK UP R.O.M.
15
CHARGE RATE P.R.O.M.
16
PROGRAM R.O.M.
17
SCRATCH PAD R.A.M.
12
DATA BUS

FIG. 1.

FIG. 2.

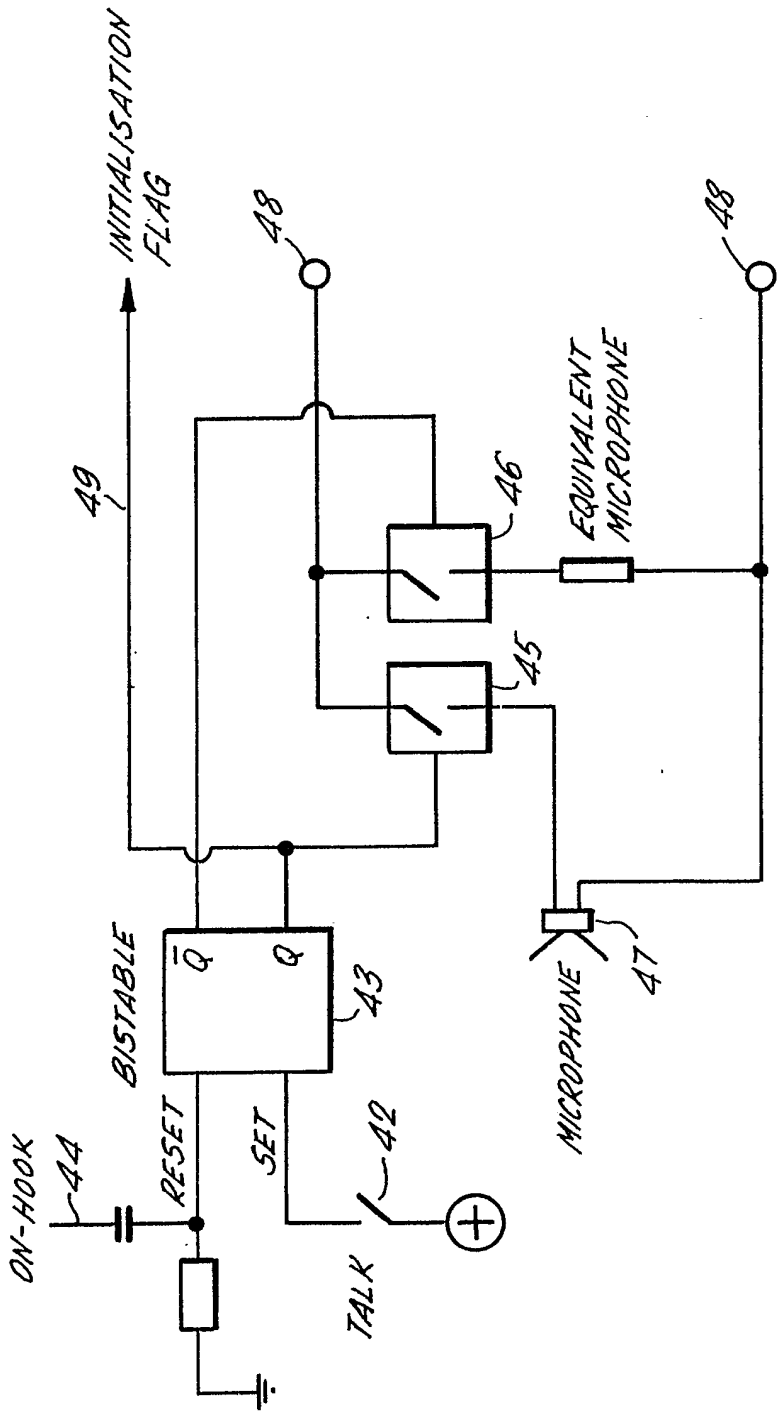

INITIALISATION FLAG
48
48
49
46
EQUIVALENT MICROPHONE
45
BISTABLE
Q̄
Q
43
MICROPHONE
47
ON-HOOK
44
RESET
SET
42
TALK

FIG. 3.

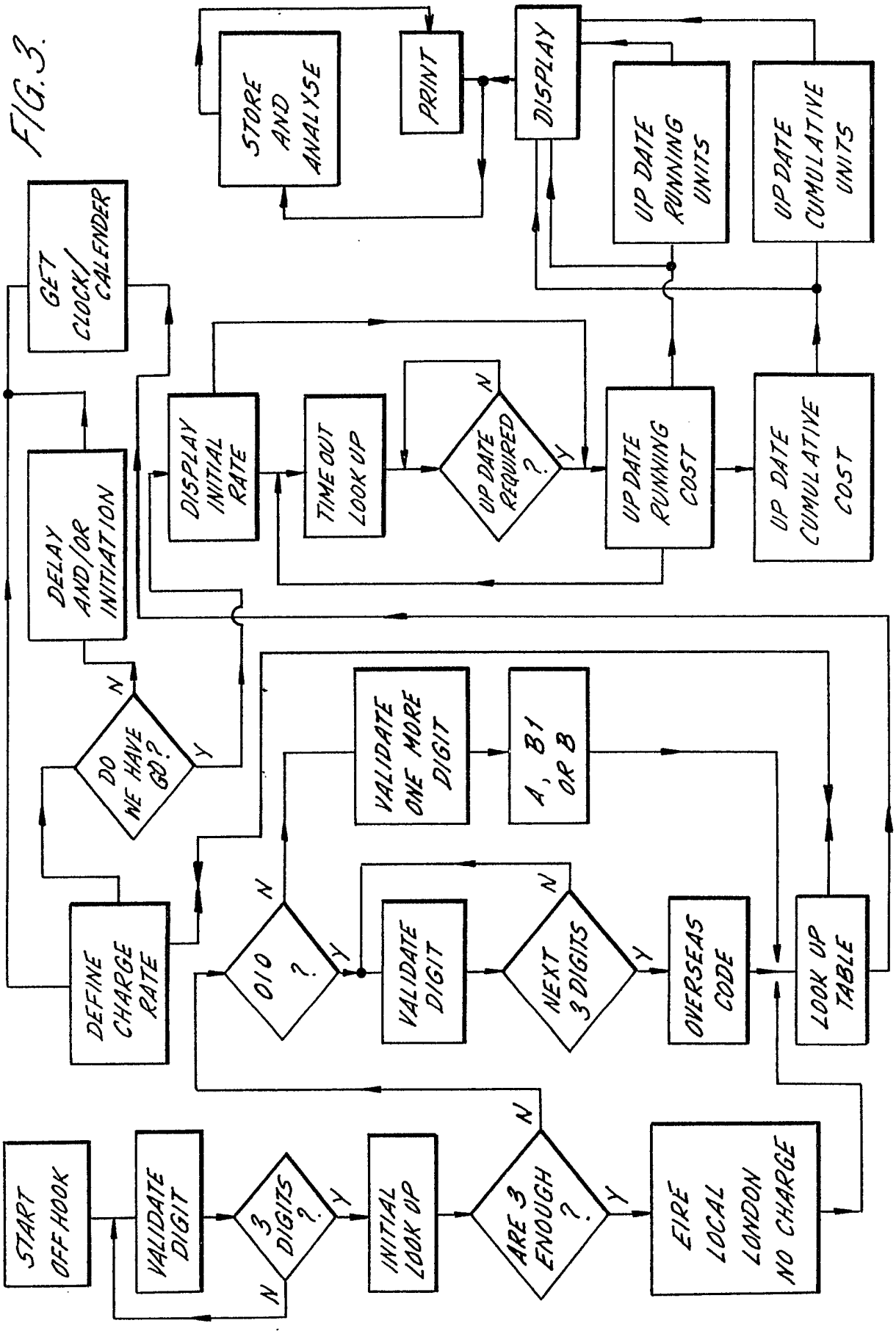
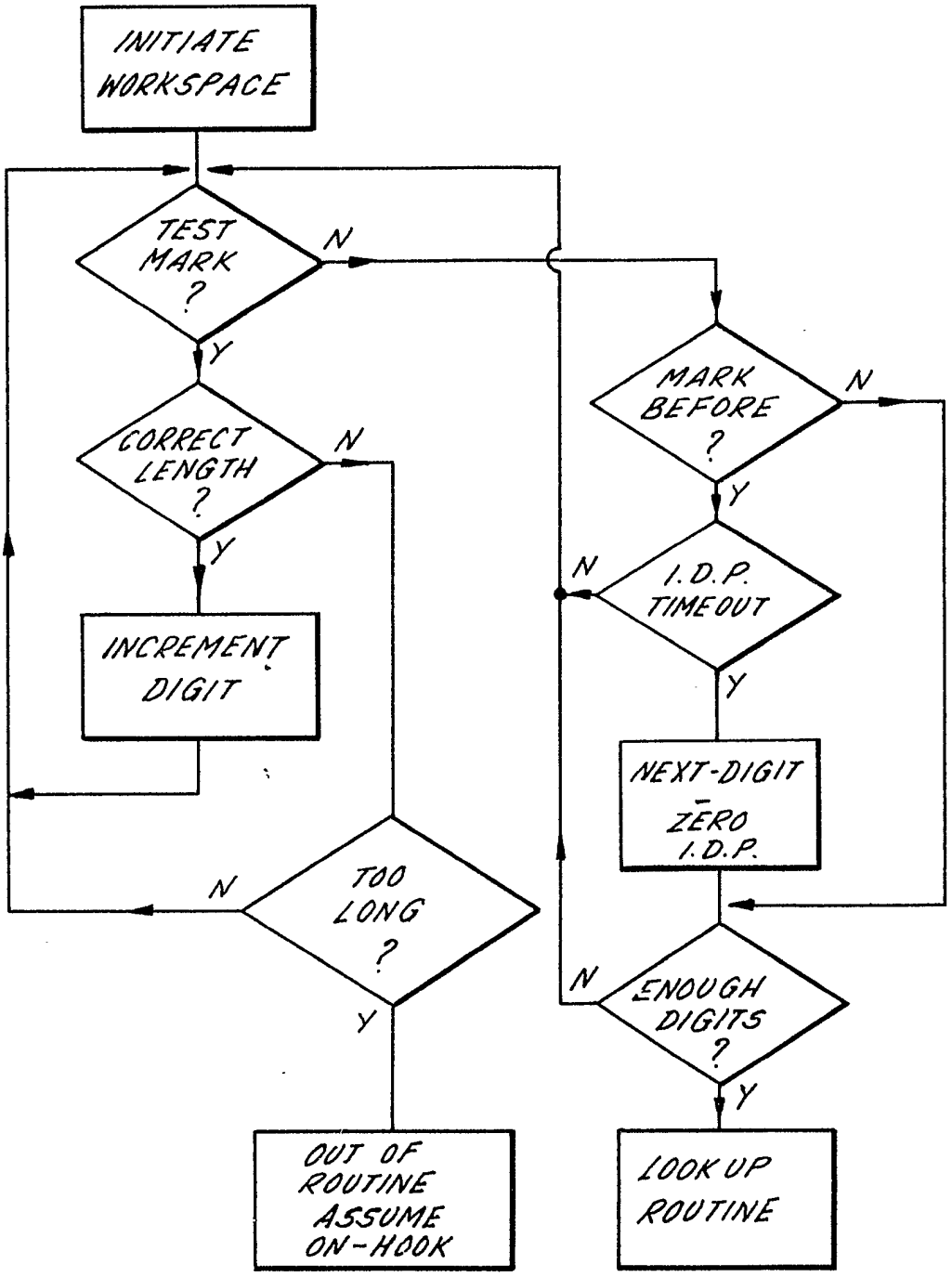

START OFF HOOK
VALIDATE DIGIT
3 DIGITS ?
N
Y
INITIAL LOOK UP
ARE 3 ENOUGH ?
N
Y
EIRE LOCAL LONDON NO CHARGE
DEFINE CHARGE RATE
010 ?
N
Y
VALIDATE DIGIT
NEXT 3 DIGITS
N
Y
OVERSEAS CODE
LOOK UP TABLE
VALIDATE ONE MORE DIGIT
A, B1 OR B
DO WE HAVE GO ?
N
Y
DELAY AND/OR INITIATION
GET CLOCK/ CALFINDER
DISPLAY INITIAL RATE
TIME OUT LOOK UP
UP DATE REQUIRED ?
N
Y
UP DATE RUNNING COST
UP DATE CUMULATIVE COST
STORE AND ANALYSE
PRINT
DISPLAY
UP DATE RUNNING UNITS
UP DATE CUMULATIVE UNITS

FIG. 4.


INITIATE WORKSPACE
TEST MARK ?
N
Y
CORRECT LENGTH ?
N
Y
INCREMENT DIGIT
TOO LONG ?
N
Y
OUT OF ROUTINE ASSUME ON-HOOK
MARK BEFORE ?
N
Y
I.D.P. TIMEOUT
N
Y
NEXT-DIGIT ZERO I.D.P.
ENOUGH DIGITS ?
N
Y
LOOK UP ROUTINE

SPECIFICATION

Telephone call cost calculator

This invention relates to a telephone call cost calculator and is concerned more particularly with the provision of call cost information to subscribers.

In the United Kingdom, when a telephone call is dialled directly, that is to say without the intervention of an operator, metering pulses are generated at the exchange by equipment which is designed basically to operate meters in the exchange for the purpose of invoicing this subscriber. By arrangement with the telephone authority, it is possible, on payment of a quaterly charge, to have these pulses routed to the subscriber's line so that they may be counted and displayed at the subscriber location, either electromechanically or electronically. The subscriber can thus obtain an indication of the cumulative cost of his calls and, by noting the readings before and after making a call, he can determine the cost of that call. The equipment required for this purpose however is such that, due to space considerations in exchanges, the telephone authorities cannot in general provide such a service except to a very limited number of subscribers.

In certain other countries, no provision at all is made for making such meter pulses available to subscribers and, in such countries, the subscriber has no means of determining the cost of calls except by utilising a stop watch and referring to his directory for the appropriate cost information.

It is an object of the present invention to provide a telephone call cost calculator for use by subscribers which does not require any metering information from the exchange.

According to this invention, a calculator for determining and indicating the cost of telephone calls from subscriber apparatus comprises a data processor a memory operatively associated with the data processor and storing program instructions therefor and also data defining call charge rates, data input means for connection to the subscriber telephone apparatus arranged for feeding to the data processor signals generated by the subscriber for making a telephone call, the data processor being programmed to compare said signals with stored information to determine the appropriate charge rate, initiate means for providing an initiate signal for initiating timing of the call, means operative on termination of the call for terminating the timing, the data processor being arranged furthermore to determine the charge for a call from the predetermined charge rate and the determined time period and display means for indicating the cost of the call. The display means are most conveniently arranged to display the cost in monetary units but the calculation may be effected in terms of arbitrary units such as are employed by the telephone authority for calculating charges. Preferably the display means is arranged for displaying the cost of an individual call and/or the cumulative cost of calls over a period.

The data processor is very conveniently a microprocessor but it is possible to use other devices which are suitably programmed, e.g. an uncommitted logic array or a dedicated "chip". In the following description, the word "processor" will be used to include all such devices.

Telephone authorities usually employ a limited number of charge rates. Commonly these rates will depend on the destination of the call and they may also depend on time of day etc. In the United Kingdom, the destination of the call, with present charging arrangements, would have to be deteremined as one of six possibilities, namely an overseas call, or local call or, if the call is not either of these, whether it is charged at the (a), (b), (b1) or (c) rates, (use of the (c) band at present is in abeyance). Overseas calls are sub-divided furthermore into a plurality of different charge bands. In other countries, the apparatus will have to be arranged to take into account the charging system employed in that country. In the present specification, reference will be made more particularly to the conditions in the United Kingdom; it will however be readily apparent to those skilled in the art how to adapt such arrangements to suit different charging regimes.

In the U.K. an overseas call is identified by the first three dialling digits being 010. If such digits are dialled, then the selection of the appropriate overseas charge band from the memory can then be determined from the next one or next few digits. Local calls commonly also are readily identifiable from the first few digits of the dialled number which again will uniquely define that a call is a local call. In the United Kingdom, the (a), (b1) and the (c) charge bands will in general have relatively few numbers which would have to be stored in the memory. All calls not identified as being overseas or local or in the (a), (b1) or (c) charge bands can then be assumed to be in the (b) charge band. The memory requirements thus are not very onerous in this respect and it is readily possible to store the identification of the charge bands in a read-only memory or in a random access memory which is programmed on installation.

Having determined the charge band, the appropriate charge rate for the time of day has to be determined and for this purpose, a clock/calender may be employed, the calender being pre-programmed, for example to indicate Saturdays, Sundays and holidays when cheaper charge rates are available. A separate clock calender unit with a crystal oscillator may be provided for interrogation by the data processor when the time data is required.

The data processor, in response to the initiate signal, may provide clock pulses at a predetermined rate, and at each clock pulse, the data processor may be arranged to implement the contents of a memory location by an amount determined by the call charge rate. Alternatively the data processor, in response to the initiate

signal may provide pulses at a rate in accordance with the selected charge rate so that the number of pulses is proportional to the computed charge.

In some circumstances, the initiate signal may be provided by means determining the establishment of a connection to the called subscriber, e.g. by sensing the end of a ringing signal or by sensing the establishment of voice communication. For simplicity however and economy, it will generally be more convenient to provide on the apparatus a button for operation by the subscriber when the charging period, for which he requires indication of charge, commences.

It may be preferred however to employ automatic means providing the initiate signal, for example after a predetermined time period which is chosen for example to represent the average delay in completion of a connection to a called subscriber. The time period may be determined from the end of the dialling signal or making use of the ringing tone which can be sensed. Such automatic means utilising an average value of a delay period may lead to minor variations between the computed charge and the true cost of a call but provides a very simple and convenient way of ensuring that recording is made of the accumulated charge for every call. Other ways will be readily apparent of ensuring recording of charging for each call; for example in a system having a push-button, means may be provided for inhibiting transmission from the calling subscriber until the button has been operated.

Power for operation of the call cost calculator may in some cases be derived from the telephone lines (where this is practical and is permitted by the telephone authority). Alternatively the telephone subscriber may provide the power, for example from the electricity supply mains. In either case, protection against supply interruption may be provided by means of standby battery.

The apparatus described above may readily be adapted for use with pay telephones or with credit card telephones. For a pay phone, particularly modern types of telephone which can accept a coin or coins and give change at the end of a call if the inserted money is in excess of the actual cost of the call, the above-described apparatus may be used, in place of present-day techniques requiring metering pulses from the exchange, to compute and indicate the cost of the call. More generally however the apparatus may be used in a pay phone for requesting insertion of further coins and for terminating the call at the end of the period paid for.

In a credit card telephone, the above-described apparatus facilitates the use of a permanent card bearing information, e.g. in a magnetic strip, identifying the account to which calls by the card user are to be charged. The above-described apparatus can be used to compute the charge and, at the end of a call, the computed charge is transmitted to the exchange in digital form together with required account data read from the card and the card is then released and returned to the user.

The apparatus also may be used at a PBX and, in this case, means may be provided for recording, e.g. by printing a read-out tape or the like, data on call with information as to the calling extension, called number, etc.

In the following description of one example of the invention, reference is made to the accompanying drawings in which:—

Figure 1 is a block schematic diagram of a telephone call cost calculator;

Figure 2 is a simplified circuit diagram illustrating one form of circuit for providing an initiate signal; and

Figures 3 and 4 are operational flow charts for explaining the functional operation of the processor for charge computing and for validating dialling impulses respectively.

Referring to Figure 1 there is shown diagrammatically a microprocessor unit 10 connected to a data bus 12 and a memory address bus 13. Connected also to these buses are a look-up read-only memory 14, a charge rate programmable read-only memory 15, a further programmable read-only memory 16 and a scratch pad random access memory 17.

The subscriber's telephone apparatus is indicated diagrammatically at 20 and includes means 21 for feeding calling signals, which in the United Kingdom are dialling pulses, to input signal conditioning apparatus 22 which converts the dial pulses into signals compatible with the microprocessor 10 and also provides a signal indicative of the line condition at the subscriber apparatus 20. These signals are provided to a display control 23 and also to an input port 24 which, via the data bus 12 provides these signals for use by the central processor unit 10.

In response to a signal from unit 22 indicative of the line condition and showing that the receiver has been lifted off the hook, the display control 23 provides a signal to one of four external flag inputs EF1—4 on the microprocessor 10. Typically this flag input is "high" if the subscriber apparatus is "on hook" and is "low" if the subscriber apparatus is "off hook". In this way the microprocessor 10 senses the condition of the line at the subscriber apparatus 20 and therefore detects when a user is about to dial the calling code.

The microprocessor 10 is controlled by a clock divider 30 and is programmed to examine the status of flag inputs EF1—4 at a predetermined rate. When a user dials a calling code from the subscriber apparatus 20, the microprocessor first detects, on one of these inputs, say EF1, which indicates "off hook", a logic 0 indicating that the apparatus is off-hook and then a logic 1 indicating either a dialling pulse or reinstatement of the "on-hook" condition. It determines, in the microprogram instructions, that the 1 existed for an appropriate time (say at least (50 ms) followed by a 0 for an appropriate time (say at least 35 ms). If the flag input EF1 goes high again, for say

more than 80 ms, it is deemed that the receiver is placed back on the hook, and then the procedure reverts to the beginning again. If, on the other hand, a valid dial pulse has been found, that is to say, a logic 1 of more than say 50 ms and less than say 80 ms, the dial pulses which are now applied via the input port are examined. Each dial pulse increments a register within the microprocessor 10 and, after a 0 has existed on EF1 for say 200 ms, which is approximately half the duration of the interdigital pause (IDP) the microprocessor assumes that the count for that dial digit is complete. The validation check is thus on both mark and space. It will be appreciated that these time durations for validating the information are chosen in accordance with the standard mark and space durations used by the telephone authority. Much higher rates of pulses may be used in some systems. The contents of the register storing the pulse counts are then transferred to a first digit slot in the aforementioned random access memory module 17 and the microprocessor advances to determine the second digit and so on. This continues until the microprocessor has extracted all the digits required for defining the appropriate charge rate for the call. It will be appreciated that, in general, only the first few digits of a dialled code would be required for this purpose. These digits are then compared with stored information in the aforementioned look-up read-only memory 14. As previously explained, this read-only memory need not store all possible codes since for example, an overseas call can be identified by the dialling code prefix 010 and the overseas charge band can then be identified from the next or the next two or possibly three digits. Many or possibly all local calls can be identified by the absence of an 0 from the beginning of the dialling code. The remaining calls starting with a prefix 0 which is not followed by 10 can be analysed so far as the U.K. is concerned, very conveniently by checking whether certain called numbers defining exchanges in band (a), (b1) and band (c) have been called and assuming that any other called number must therefore be in band (b).

When the charging band has been determined, the microprocessor then has to investigate the temporal status in all cases where the actual charging rate depends on the time of day. The clock divider 30 drives a clock/calendar unit within the program of the microprocessor 10 which establishes the time/day information and via the charge rate programmable read-only memory 15 provides the actual charging rate information to the data bus 12 for feeding to the microprocessor. The clock/calendar contains not only time and day of the week but also specific days such as Bank Holidays where the charge rates differ from normal. The clock divider unit 30 might incorporate a crystal oscillator and might be connected to the data bus 12 so that time information is available by interrupt of a wait state of the microprocessor. In the embodiment illustrated, the microprocessor unit 10 has an internal crystal clock circuit 40 and the external clock divider unit 30 comprises a divider which produces interrupt signals to the microprocessor at intervals of say 0.1 seconds. The divider might be arranged to modify these time intervals in accordance with charge rate demands. The programmable read-only memory services such requests for time information and increments the time and date data which is held in the scratch pad random access memory.

The computation of the charge requires determination not only of the charge rate but also of the duration of the call. Initiate means 41 feed an initiating signal into the display control 23 and thus sets one of the flag inputs of the microprocessor 10. Termination of the call is most conveniently detected by the replacing of the subscriber receiver on the hook so giving the on-hook condition signal via input conditioning unit 22 and display control 23 to a flag input of the microprocessor.

As previously explained, the initiate signal may be derived in a number of different ways and commonly it may be preferred to make use of one or a combination of sources of the initiate signal. One simple way of producing the initiate signal is illustrated in Figure 2. This figure shows the initiate means 41 of Figure 1 together with part of the telephone apparatus 20. Essentially it has a switch 42, conveniently a push-button switch with automatic spring return, which provides a set signal for a bistable 43 which bistable is automatically reset by an "on hook" signal on a lead 44. Setting of the bistable closes a switch 45 in the transmission circuit from the microphone 47 of the telephone apparatus to the transmission output terminals 48 of the transmission circuit from the microphone. Thus the transmission circuit from the microphone is only completed on operation of the switch 42. The condition of the bistable is also transmitted via a lead 49 to one of the flag inputs of the microprocessor, this flag input being referred to as the initialisation flag. With this arrangement, the subscriber cannot speak to the called subscriber until the push-button 42 has been operated. At the end of the call, replacement of the receiver on the hook resets the bistable 43 and so releases switch 45 but closes switch 46 to incorporate an impedance 50 in the transmission circuit equivalent to the microphone impedance to avoid disturbing the line conditions.

It will be appreciated however that there are many other possible ways of providing an initiate signal. If it is desired to avoid any modification of the telephone apparatus and thus not to have the transmission inhibit facility, it is still possible to use a push-button to provide the initiate signal but, in this case, it may be preferred to provide an additional source of this signal so that cost calculation is effected even if the button is not operated. In some cases it may be convenient to make use of a signal derived from the exchange and passed down the calling subscriber's line. If signal exists in the calling subscriber's exchange

to initiate charging there this signal could be imposed on the line more simply than feeding meter pulses. A transient line polarity reversal, for example, would serve the purpose and be simple to implement in the exchange. However, the use of the push-button switch 42 obviates any need to modify exchange equipment in any way. Other more complex techniques may be employed which obviate the necessity for manual operation of the push-button 42. For example equipment could be provided which recognises the differences between impulses dialling or tone dialling and speech on the line. Then a simple time analysis, consisting of repetitive interrogation of the external flag could produce information that speech is present rather than any other system condition and this recognition of speech can be used to initiate the timing.

Power for the device may in some cases be provided from the telephone line. In this case the system would be in a stand-by low power state until awakened by an interrupt from the clock divider. Alternatively the subscriber's domestic alternating power supply might be used. In either case, any volatile memory can be protected from supply interruption by battery operation in a "stand-by" mode.

The computed output information is fed from the microprocessor via data bus 12 and an output port 52 to a display unit 53, conveniently a liquid crystal display with seven segment display units. These require an alternating current feed and the data decoders can conveniently be fed with clock pulses derived from the clock/calender circuitry.

Figure 3 is a flow diagram for explaining the programming of the microprocessor. This program which starts from the indication that the subscriber has lifted his receiver off the hook essentially validates the dialling digits and having checked the initial digits determines whether the dialling code is for an overseas call, or for an internal call. If it is for an overseas call, the next three digits are entered and these are then analysed to determine the appropriate charge band. If the call is not an overseas call, a check is made as to whether the first digit is a 0 or not a 0. If it is a 0, the call is generally not a local call. If the first digit is a 0, the next digits are compared with the stored information to obtain the charge band. This part of the flow diagram will now be explained in further detail.

When a number is dialled its first three digits are temporarily put, under microprocessor program control, into a register. These first three digits of the number are then compared with a plurality of permanently stored conditions to establish the start point of a search. One search is initiated by 010, the overseas code. Any other combination of digits after zero for the next digits indicates that the call is not an overseas call. In the U.K., in general, the absence of an 0 as the first digit is indication that the call is a local call and no further identification is required. If the first digit is an 0, which is not followed by 10, then the first few digits will have to be checked against stored information to determine the charge band, that is (a), (b) or (b1) under present arrangements. If the first three digits are 010 (foreign code) then the dial validation continues to establish the second three digits. These will be sufficient to determine the charge band.

Since in general only three digits after the initial zero are required to identify the charge band, a two byte system may be employed, the first byte holding the first two digits of the code and the second byte holding the third digit of the code in the upper nibble, the lower nibble carrying the charge band information.

Whichever branch in the microprocessor program takes place an area of memory conveniently, but not necessarily, semi-conductor electrically programmable and ultra violet erasable read-only memory is scanned step by step until coincidence is achieved. When this occurs the lower nibble of the second byte is extracted and transferred into a microprocessor register. This is the charge band code. When the charge band code has been extracted the program branches to investigate the temporal status by interrogation of the clock. Thus having established the particular charge band, the time/day information routes the calculation to the relevant charge information. The clock information contains not only time and day of the week, but certain specific days such as Saturdays and Sundays and Bank Holidays and other days, to which discount rates apply. The charge is indicated on a four or five digit L.C.D. display.

The validation of the dial pulses has been briefly described previously. As shown in Figure 4, this is effected by soft-ware programming of the microprocessor. Dial pulses consist of a defined mark/space ratio of make/break across the line at a defined pulse rate. In the U.K. the rate is 10 i.p.s. with M/S of 60:40. The input conditioning takes these 50v (in U.K.) pulses and translates them to a C.P.U.—compatible level (say 5v). Dialled number validation is carried out as follows:— The line condition can be sensed in a number of ways by the C.P.U., one convenient method being through one of the four external flags (E.F.). There are a number of conditional branch routines dependent upon the state of the flag, and this is a convenient facility.

On hook E.F.+1 (i.e. line voltage high)
Off hook E.F.=0

So the state of the line can be interrogated by the C.P.U. The program would detect first a '1', check that '1' exists for an appropriate time (say at least 50 ms) followed by a zero for an appropriate time (say 35 ms). A previously zeroed register is then incremented. E.F. is intermittently interrogated thereafter. If E.F. goes high again, within, say, 50 ms, the procedure is repeated, and the register accumulates the dialled digit as the pulses are validated. Various levels of additional security of validation can readily be introduced, though this is generally more relevant when recording the dialled number remotely, e.g. the exchange end of the line, more prone to spurious

data. For example E.F. can be checked repetitively (say every 1 ms) to confirm that it was continuously in that state for a given time. It can be checked on the basis of 'n' consecutive answers being the same—or a majority vote—and so on, depending upon the sophistication required. All that is required is a very little additional software. If a zero state exists for say 200 ms nearly half the I.D.P.—then the count for that digit is complete, the register content is transferred to the "first digit" slot in memory, and the system is ready to interrogate the second digit, and so on.

While a system for the U.K has been described, although the situation may be different in other countries in terms of the rate of impulsing, Mark/Space ratio, and I.D.P., this only requires different constants in the validation part of the program. In some instances, systems other than "loop disconnect" are employed for dialling, e.g. M.F. tone dialling. In these instances the device contains an appropriate decoder inserted in the system before the validation circuitry.

After the first three digits the C.P.U. compares these with the stored codes, and quickly decides if they amount to "010" (which it can do very readily with the I.D.P.) and if 'yes' it requires another three digits. If 'no' it proceeds with the main search, as described previously.

Having determined the charge bands, the clock/calendar information must be obtained to define the charge rate and the call time duration must be determined from the initiate signal and the termination signal which signals are obtained as previously described. The microprocessor then has to determine the running cost which is displayed on the display 53 as the cost of the call in progress. The display unit would normally have control means, e.g. a switch to enable the subscriber to display the cumulative cost of all calls since the cumulative cost adder was last reset.

The apparatus described above finds particular application in association with or as part of a pay telephone. It may be used automatically not only to compute and display the running cost of a call being made but also to control the payment mechanism, e.g. to signal for the user to insert further money. It will be noted that the above-described apparatus permits this to be done without requiring the transmission of metering impulses from the exchange to the telephone apparatus. This, in particular, facilitates the installation of pay telephones in hotels and other establishments as such a pay telephone can operate without requiring any special facilities at the exchange. Moreover, the telephone owner can set the charges for payment of telephone calls as desired without making use of any charge computing facilities of the telephone authority.

The apparatus furthermore facilitates the provision of facilities for paying for telephone calls using a credit card, particularly a card having data, e.g. on a magnetic strip, identifying an account to be charged. The computer charge and other data may, for example, be transmitted at the end of a call to the exchange or a billing station.

Claims

1. A calculator for determining and indicating the cost of telephone calls from subscriber apparatus, which calculator comprises a data processor, a memory operatively associated with the data processor and storing program instructions therefor and also data defining call charge rates, data input means for connection to the subscriber telephone apparatus arranged for feeding to the data processor signals generated by the subscriber for making a telephone call, the data processor being programmed to compare said signals with stored information to determine the appropriate charge rate, initiate means for providing an initiate signal for initiating timing of the call, means operative on termination of the call for terminating the timing, the data processor being arranged furthermore to determine the charge for a call from the predetermined charge rate and the determined time period and display means for indicating the cost of the call.

2. A calculator as claimed in claim 1 wherein the data processor is a microprocessor.

3. A calculator as claimed in either claim 1 or claim 2 wherein the display means are arranged to display the determined cost in monetary units.

4. A calculator as claimed in any of the preceding claims wherein the display means are arranged for selectively displaying the cost of an individual call and the cumulative cost of calls over a period.

5. A calculator as claimed in any of the preceding claims wherein the data processor, in response to the initiate signal, provides pulses, at a rate determined by the ascertained call charge rate so that each pulse corresponds to a unit of charge, to increment the contents of a memory location, such that said contents will represent the current cost of the call.

6. A calculator as claimed in any of claims 1 to 4 wherein the data processor, in response to the inititate signal, provides a clock pulse at a predetermined rate, so that each pulse corresponds to a unit of time, to increment the contents of a memory location, at each clock pulse, by an amount in accordance with the determined call charge rate whereby the contents of the memory location represent the current cost of the call.

7. A calculator as claimed in any of the preceding claims wherein the initiate signal is provided by means sensing when the called subscriber has gone off hook.

8. A calculator as claimed in any of claims 1 to 6 wherein the initiate signal is provided by means sensing the completion of the connection to the called subscriber.

9. A calculator as claimed in any of claims 1 to 6 wherein the initiate signal is provided by means sensing the end of the ringing tone on completion of the connection.

10. A calculator as claimed in any of claims 1 to 6 wherein means are provided for sensing the

ringing tone on completion of the connection and wherein the initiate pulse is provided by delay means for delaying the initiate signal until a predetermined time period after sensing the ringing tone.

11. A calculator as claimed in any of claims 1 to 6 and having means responsive to the sensed completion of dialling for generating the initiate signal.

12. A calculator as claimed in any of claims 1 to 6 wherein the initiate signal is provided by means responsive to dialling pulses and including delay means for delaying the initiate signal for a predetermined time period after sensing the completion of dialling.

13. A calculator as claimed in any of the preceding claims and having a subscriber-operated push-button or key for generating the initiate signal.

14. A calculator as claimed in claim 13 wherein means are provided inhibiting transmission from the calling subscriber until the push-button or key is operated.

15. A calculator as claimed in any of the preceding claims wherein the means for determining the appropriate charge rate comprises means for determining the appropriate charge band together with a clock/calendar, the calendar being pre-programmed, to indicate days and time-periods during days when cheaper charge rates are available.

16. A calculator as claimed in any of the preceding claims wherein a call-terminate signal is provided to said microprocessor from the hook-switch of the subscriber apparatus.

17. A calculator as claimed in any of the preceding claims wherein at least part of the memory is an electrically programmable read-only memory.

18. A calculator as claimed in any of the preceding claims and wherein said data processor is arranged to validate sensed dialling pulses by checking that both mark and space periods fall within predetermined limits of duration.

19. A calculator as claimed in any of the preceding claims and arranged for use with a pay telephone wherein the display means are arranged to indicate the running cost of a call in progress.

20. A calculator as claimed in claim 19 and arranged to control the call duration in accordance with payments made by insertion of coins.

21. A calculator as claimed in any of claims 1 to 18 and in combination with credit card payment telephone wherein the calculator is arranged to accept a card bearing encoded information identifying an account to which a call is to be charged and wherein means are provided operative, at the termination of a call, to transmit data, from the telephone to an exchange or billing station, representative of the determined cost of the call and of the account to be charged.

22. A calculator for determining and indicating the cost of a telephone call or calls from subscriber apparatus substantially as herein-before described with reference to the accompanying drawings.

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